INST 2403 Activity

Stellar Models

We want to explain how stars function. That is, we want to build a model of a star that is consistent with the known laws of Nature and explains all the properties of stars.

First, let's review what we actually know about the stars from observing them.

1. List five properties of stars that we can glean from observations.

   - temperature
   - color
   - spectral class
   - luminosity
   - size
   - chemical composition

2. There are other things we know about stars from observations which are NOT properties of the star. Explain why the distance to a star and its radial and transverse velocities are not properties of the star.

   distance & velocity are relative to the observer, and therefore not part of a description of the star itself.

3. Describe briefly which general features of stars we have to explain. Take into account that stars come in different colors, temperatures and luminosities, and are subject to the force of gravity.

   - How are stars stable if they are squeezed by gravity?
   - Why do different stars have different colors, luminosities, etc?

4. A crude model of stars is to view them as hot glowing gas balls. Explain what we mean by this.

   Hot gas balls are held up by gas pressure, due to the fact that they are hot inside, cold outside, so convective motion props them up against the force of gravity

5. The key ingredient to a star's stability is hydrostatic equilibrium. Explain the concept.

   See above. Gravity & gas pressure have to be balanced ("in equilibrium") to make the star stable. We do not want the star to shrink nor expand.

6. The earliest stellar model was Homer Lane's description of a star as a gas ball propped up by convective motion. Convection is one form of energy transport. Describe how it works.

Put simply, convection is "hot stuff" rising and cooler stuff sinking. Therefore, pressure is built up by heating "stuff".

7. What was Eddington's contribution? How did he modify Lane's model?

Eddington replaced convection in Lane's model by radiation as the dominant mode of energy transfer.

8. One of the successes of Eddington's standard model was the prediction of the mass-luminosity relation. Explain what that is.

It's the correlation between mass of a star and its luminosity or energy output. The higher M, the higher L:

$$L \propto M^{3.5}$$

9. What problems were left to solve after Eddington's "standard model" of stars explained many features of stars?

Eddington did not at all address how energy is produced inside stars.